REMARKS

Claims 1-29 were pending. In response to the present Office Action, the Applicant has amended claims 1, 7, 11, 12, 14, 17, 23, and 27, and cancelled claims 2, 13, and 18, leaving claims 1, 3-12, 14-17, and 19-27 for the Examiner's consideration. No new matter has been added.

In summary of the present Office Action, the Examiner has:

I. Objected to the specification for informalities;

II. Rejected claims 1-27 under 35 U.S.C. §112;

III. Rejected claims 1, 3-12, 15-17, and 19-29 under 35 U.S.C. §101; and

IV. Rejected claims 1-29 under 35 U.S.C. 102(b).

The Applicant respectfully traverses these rejections.

I. Objection to the specification.

The Office Action objects to the specification due to informalities in paragraphs [0019], [0020], and [0025]. The Applicant has amended the specification to correct these informalities and respectfully request the withdrawal of this objection.

II. Rejected claims 1-27 under 35 U.S.C. §112.

The Office Action rejects to claims 1-27 under 35 U.S.C. §112(1) because the specification allegedly does not enable the assignment of a state to spray particles other than velocity. The Applicant respectfully disagrees.

Page 7, paragraph [0022] of the Applicant's specification states that "once the boundary region is defined, a set of spray particles is added, or seeded to the boundary region." Applicant's figure 4D illustrates example spray particles added to the boundary region. As can be seen in figure 4D, each of the spray particles added to the boundary region has a position. The Applicant respectfully submit the position of each spray particle is a part of its state, in addition to its velocity. Accordingly, the Applicant respectfully requests the withdrawal of this rejection for at least this reason.

The Applicant notes that the state of the spray particle is not limited to position and velocity attributes. For example, page 7, paragraph [0025] of the Applicant's specification notes that the spray particles can be rendered to create an output image. This portion of the Applicant's specification states that "rendering can be performed using any technique, for example ray-tracing or scanline rendering, in combination with lighting, shading, texture mapping, and any other image processing information to create a final image or frame." Thus, lighting, shading, texture mapping, and any other image processing information used to render a spray particle may be considered attributes of the spray particle's state.

With regard to claims 1 and 17, the Office Action further alleges that the specification enables assigning a velocity to spray particles based on the weighted velocity of adjacent grid points and not as derived from the attributes of the fluid surface. Accordingly, the Applicant has amended claims 1 and 17 to recite that "the spray particle ha[s] an initial state derived at least in part from the attributes of the fluid <u>simulation.</u>" (Emphasis Added).

The Applicant respectfully submits that the specification fully enables these amended claims. For example, the Applicant's specification states that a "fluid simulation 400 models the behavior of a fluid as a set of particles." (p. 6, paragraph [0019]. "A level set 430 defining the surface of the fluid is created by weighting the velocities of particles adjacent to grid points to determine a velocity of each grid point." (p. 6, paragraph [0020]). The initial velocity assigned to a spray particle is determined from the grid point velocity, which in turn is derived from the particles of the fluid simulation.

In another example, the spray particles are assigned initial positions within the boundary region. (p. 7, paragraph [0022]). The boundary region is defined between a boundary surface at a non-zero level of the level set equation and the fluid surface. (p. 6, paragraph [0021]). Both the fluid surface and the level set equation are derived from the fluid simulation. (p. 6, paragraph [0020]). Thus, the initial position assigned to a spray particle is derived at least in part from the fluid simulation.

Because at least part of the initial state of a spray particle, such as the initial velocity and initial position, are derived from the fluid simulation, the Applicant submits that the specification discloses that "the spray particle ha[s] an initial state derived at least in part

from the attributes of the fluid simulation" and respectfully requests the withdrawal of this rejection for this additional reason.

Claims 11 and 27 have been amended similarly to claims 1 and 17. As amended, both claims 11 and 27 recite that "the additional spray particle ha[s] an initial state derived at least in part from the attributes of the fluid simulation." The Applicant submits that claims 11 and 27 are enabled by the specification for reasons similar to those stated for claims 1 and 17.

Claim 12, as amended, recites that "the plurality of spray particles is assigned an initial state derived at least in part from the state of the set of fluid particles." The Applicant respectfully submits that this claim element is enabled by the specification. As discussed above, paragraph [0019] states that a fluid simulation models the behavior of a fluid as a set of fluid particles. Paragraph [0020] states the velocity of each grid point is determined by weighting the velocities of fluid particles adjacent to the grid points. Paragraph [0022] states that the spray particles are assigned a velocity based on the weighted velocity of adjacent grid points. Thus, the spray particles have an initial state derived at least in part from the attributes of the fluid simulation, as recited by claim 12. Accordingly, the Applicant respectfully requests the withdrawal of this rejection.

III. <u>Rejection of claims 1, 3-12, 15-17, and 19-29 under 35 U.S.C. §101.</u>

The present Office Action rejects claims 1, 3-12, 15-17, and 19-29 under 35 U.S.C §101. The Applicant has amended claim 1 to include the limitations of claim 2, which has not been rejected on these grounds. Accordingly, the Applicant submits that claim 1, as amended, satisfies the requirements of 35 U.S.C. §101 and respectfully request the withdrawal of this rejection to claim 1 and its dependent claims.

Similarly, the Applicant has amended claims 12 and 17 to include the limitations of claims 13 and 18, respectively, which have not been rejected on these grounds. Accordingly, the Applicant submits that claims 12 and 17, as amended, satisfy the requirements of 35 U.S.C. §101 and respectfully request the withdrawal of these rejections of claims 12 and 17 and their respective dependent claims.

With regard to claims 28 and 29, the present Office Action states that claims 28 and 29 are directed to non-functional descriptive material. The Applicants respectfully

disagree. Claims 28 and 29 are product-by-process claims. A product-by-process claim is a product claim that defines the claimed product in terms of the process by which it is made. (MPEP 2173.05(p)). Claim 28 is directed to a product, "a tangible media including a first image . . . and a consecutive image." Claim 28 specifies that this product is made according to the process defined by the method of claim 1. Claim 29 is directed to a similar product created according to the process defined by the method of claim 12. Because claims 28 and 29 are directed to tangible products created according to specific processes, the Applicants respectfully submit that claim 28 and 29 are statutory subject matter satisfying the requirements of 35 U.S.C. §101.

IV. Rejection of claims 1-29 under 35 U.S.C. §102(b).

The present Office Action has rejected claims 1-29 under 35 U.S.C §102(b) as anticipated by Foster et al., "Practical Animation of Liquids," SIGGRAPH 2001, August 2001, pages 23-30 ("Foster"). The Applicants respectfully traverse this rejection.

Claim 1, as amended, recites in part:

> moving the spray particle independently of the fluid simulation according to at least its initial state. (Emphasis Added).

As discussed above, claim 1 specifies that an initial state of a spray particle is derived at least in part from the fluid simulation. However, once the initial state of the spray particle is defined, claim 1 states that the spray particle is moved "independently of the fluid simulation." "Because the spray particles are not animated with a computationally expensive fluid simulation, the addition of the spray particles does not adversely effect the performance of the overall fluid animation." (Specification, p. 8, paragraph [0026]). Foster does not disclose or suggest at least this element of claim 1.

Foster discloses a fluid animation system using a "combination of both inertialess particles and an implicit surface called a level set." (Foster, p. 23, right column, paragraph 3). Foster uses a fluid simulation, in the form of Navier-Stokes equations, to define a liquid velocity field (**u**). (Foster, p.24, equations 3.1 and 3.2). "By solving (3.1) and (3.2) over time, [Foster models] the behavior of a volume of liquid." (Foster, p.24, right column, paragraph 2). In Foster, the velocity field is continually updated according to the

fluid simulation. Foster states that "for each simulation time step III. Update the velocity field by solving [fluid simulation equation] (3.2)." (Foster, p. 24. right column).

According to Foster, the particles are always moved according to the velocity field, and hence, always moved to according to the fluid simulation. Foster states that "particle velocity is computed directly from the velocity grid using tri-linear interpolation and each particle is moved according to the inertialess equation $dx_p/dt = v_x$, where v_x is the fluid velocity at x_p." (Foster, p. 25, left column, paragraph 3). In Foster, a particle's movement at any point in time (i.e. dx_p/dt) is based on the value of the velocity field (v_x) at the particle's current position (x_p) at that point in time. As particles in Foster move and simulation time progresses, the particles' positions and velocities are updated according to the velocity field. Foster states that "for each simulation time step VI. Update the position of the liquid volume (particles and implicit surface) using the new velocity field." (Foster, p. 24. right column).

Thus, Foster discloses solving fluid simulation equations over time to determine a velocity field. The movement of particles in Foster is specified by the velocity field values at the particles' positions. Therefore, the movement of particles in Foster is always dependent upon the fluid simulation.

In contrast to Foster, claim 1 specifies that a spray particle moves "independently of the fluid simulation according to at least its initial state." In claim 1, once a spray particle receives its initial state, its subsequent movements are independent of the fluid simulation. In Foster, the particles always move according to the velocity values of the fluid simulation. In claim 1, the spray particles are "decoupled" from the fluid simulation and move independent of the fluid simulation. There is nothing in Foster that discloses or suggests moving particles under the influence of anything other than the fluid simulation.

Because claim 1 specifies that a spray particle moves "independently of the fluid simulation," the Applicant respectfully submits that claim 1 and its dependent claims are patentable over Foster for at least this reason. Claims 11, 12, 17, 27, 28, and 29 recite similar limitations and the Applicant submits that claims 11, 12, 17, 27, 28, and 29 and their respective dependent claims are patentable over Foster for similar reasons.

Additionally, claim 5 recites:

> solving the level set equation to determine a non-zero level corresponding to a boundary surface; and

> adding the spray particle to a boundary region between the fluid surface and the boundary surface.

Foster does not disclose or suggest either of these elements.

Foster discloses solving a level set equation (equation 5.2) to determine the fluid surface defined by the level set function $\Phi(x) = 0$. (Foster, p. 26, left column, first paragraph). However, Foster does not disclose solving this same type of equation for a non-zero value to determine a boundary surface, as recited by claim 5.

According to the Office Action, Foster states that "if a particle is more than a few grid cells away from, and inside the surface, as indicated by the locally interpolated value of Φ, then that particle is deleted." (Foster, p. 26, left column, paragraph 3). This portion of Foster discusses measuring the distance between a particle and the surface defined by $\Phi(x) = 0$. It does not disclose or suggest solving the level set equation (5.2) for a non-zero value to define a boundary surface different from the fluid surface. Therefore, Foster does not disclose or suggest this element of claim 5.

Furthermore, claim 5 calls for "adding the spray particle to a boundary region between the fluid surface and the boundary surface." However, the portion of Foster cited by the Office Action with regard to claim 5 discuss removing, not adding particles. Foster states that "if a particle is more than a few grid cells away from, and inside the surface, . . . <u>then that particle is deleted</u>." (Foster, p. 26, left column, paragraph 3). (Emphasis Added).

Moreover, there is nothing in any other portion of Foster that discloses or suggests adding particles to a boundary region. Foster discloses that "extra particles can be introduced 'within' the isocontour." (Foster, p. 26, left column, paragraph 3). In Foster, the isocontour is the fluid surface. "An alternative technique for representing the liquid surface is to generate it from an isocontour of an implicit function." (Foster, p. 25, left column, paragraph 4). Thus, Foster discloses adding particles on the fluid surface, not "between the fluid surface and the boundary surface" as recited in claim 5. Therefore, Foster does not disclose or suggest this element of claim 5. Claims 15 and 21 recite similar elements as claim 5 and are patentable over Foster for similar reasons.

Additionally, claim 6 recites:

> adding the spray particle to a region within a specified depth from the fluid surface.

Foster does not disclose or suggest this claim element.

With regard to claim 6, the Office Action cites a portion of Foster stating that "if a particle is more than a few grid cells away from, and inside the surface, as indicated by the locally interpolated value of Φ, then that particle is deleted." (Foster, p. 26, left column, paragraph 3). As discussed above, this portion of Foster discusses removing particles outside of a specified distance from the surface, not adding particles to "a region within a specified depth from the fluid surface," as recited by claim 6. Therefore, Foster does not disclose or suggest this element of claim 6.

Claim 7 recites:

> moving the spray particle in accordance with a ballistic simulation based upon at least the initial state of the spray particle.

Foster does not disclose or suggest this claim element.

Foster discloses the use of inertialess particles. Foster states that "We correct for this by tracking the motion of the liquid surface using a novel hybrid combination of <u>inertialess particles</u> and an implicit surface." (Foster, p. 23, right column, paragraph 3). (Emphasis Added). In Foster, "particle velocity is computed directly from the velocity grid using tri-linear interpolation and each particle is moved according to the <u>inertialess equation</u> $dx_p/dt = v_x$, where v_x is the fluid velocity at x_p." (Foster, p. 25, left column, paragraph 3). (Emphasis Added).

Foster uses inertialess particles because all particles in Foster derive their velocity directly from the velocity field. As a particle in Foster moves to a new position, its velocity instantly changes to the velocity value at that position. The inertialess equation disclosed by Foster does not include any terms that account for a particle's previous velocity, a particle's momentum, or its inertia. Because the particles of Foster are inertialess, the particles can change their velocity instantaneously. This allows the particles to exactly follow the velocity field.

In contrast, claim 7 calls for moving the spray particle in accordance with a ballistic simulation. A ballistic simulation models the movement of objects under their own momentum and any external forces, such as gravity. Because a ballistic simulation includes momentum, objects under ballistic motion necessarily include inertia.

A ballistic simulation is the opposite of an inertialess particle system, such as that described by Foster. In a ballistic simulation, if an example spray particle is assigned an initial velocity and there are no external forces, then the spray particle will continue moving with the same velocity indefinitely. In an inertialess particle system such as Foster, a particle's velocity changes instantaneously with its position as it moves through the velocity field. If the velocity field value is zero at some position, then the particle stops, regardless of the particle's previous velocity value.

Because Foster discloses an inertialess particle system, Foster does not disclose or suggest a ballistic simulation of spray particles, which necessarily includes particle inertia. The Applicants submit that claim 7 is patentable over Foster for at least this reason. Claims 16 and 23 recite similar elements as claim 7 and are patentable over Foster for similar reasons.

CONCLUSION

In view of the foregoing, the Applicants believe all claims now pending in this Application are patentable and in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

The Applicants invite the Examiner to contact the undersigned if the Examiner believes a telephone conference would expedite the prosecution of this Application.

Respectfully submitted,

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